

DECLARATION OF DR. RANDELL L. MILLS

I, Randell L. Mills, declare and state as follows:

1. I am the founder and CEO of BlackLight Power, Inc., located at 493 Old Trenton Road, Cranbury, New Jersey 08512.
2. I majored in chemistry and received my bachelor of arts degree, *summa cum laude* and Phi Beta Kappa, from Franklin & Marshall College in 1982. I received a medical degree from Harvard Medical School in 1986. While attending Harvard Medical School, I concurrently spent a year taking courses in advanced electrical engineering at the Massachusetts Institute of Technology. I have also had significant academic training in biology, chemistry, mathematics and physics.
3. I began my research in the field of energy technology over ten years ago. I have authored, co-authored or collaborated on numerous publications, reports and presentations at scientific meetings in the field of energy technology and novel hydrogen chemistry, as shown in the attachment hereto.
4. I am fully qualified to conduct the research that led to the discovery and development of BlackLight's lower-energy hydrogen technology.
5. I personally conducted and/or supervised the experimental data disclosed in the articles submitted to the U.S. Patent and Trademark Office ("PTO"), which are described in the following Paragraph Nos. 6 through 24. The coauthors, if any, assisted me in preparing the data.
6. R. Mills, W. Good, A. Voigt, Jinquan Dong, "Minimum Heat of Formation of Potassium Iodo Hydride, Int. J. Hydrogen Energy," in press. [Copy submitted to PTO in Exhibit 1.] Potassium iodo hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy,  $^1H$  and  $^{39}K$  nuclear magnetic resonance spectroscopy, Fourier transform infrared spectroscopy, electrospray ionization time of flight mass spectroscopy, liquid chromatography/mass spectroscopy, thermal decomposition with analysis by gas chromatography, and mass spectroscopy, and elemental analysis. I report measurements of heats of formation of KHI by differential scanning calorimetry (DSC) on a very reliable

commercial instrument, a Setaram HT 1000 DSC. With reactant  $KI$  present, potassium metal catalyst and atomic hydrogen were produced by decomposition of  $KH$  at an extremely slow rate under a helium atmosphere to increase the amount of atomic hydrogen by slowing the rate of molecular hydrogen formation. Since not all of the starting materials reacted, the observed minimum heats of formation were over  $-2000\text{ kJ/mole H}_2$ , compared to the enthalpy of combustion of hydrogen of  $-241.8\text{ kJ/mole H}_2$ .

7. R. Mills, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, submitted. [Copy submitted to PTO in Exhibit 2.] From a solution of a Schrödinger-type wave equation with a nonradiative boundary condition based on Maxwell's equations, I predicted that atomic hydrogen may undergo a catalytic reaction with certain atomized elements such as cesium and strontium atoms or certain gaseous ions such as  $Ar^+$  which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen,  $27.2\text{ eV}$ . The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen with the release of energy. Intense extreme ultraviolet (EUV) emission was observed from incandescently heated atomic hydrogen and the atomized catalysts that generated the plasma at low temperatures (e.g.  $\approx 10^3\text{ K}$ ). No emission was observed with cesium, strontium, argon, hydrogen, or an argon-hydrogen mixture (97/3%) alone or when sodium, magnesium, or barium replaced strontium or cesium with hydrogen or with an argon-hydrogen mixture. The emission intensity of the plasma generated by the cesium or strontium catalyst increased significantly with the introduction of argon gas only when  $Ar^+$  emission was observed.  $Ar^+$  which served as a second catalyst was generated by the formation of a plasma with cesium or strontium catalyst. Emission was observed from a continuum state of  $Cs^{2+}$  and  $Ar^{2+}$  at  $53.3\text{ nm}$  and  $45.6\text{ nm}$ , respectively. The single emission feature with the absence of the other corresponding Rydberg series of lines from these species confirmed the resonate nonradiative energy transfer of  $27.2\text{ eV}$  from atomic hydrogen to atomic cesium or  $Ar^+$ . The catalysis product, a lower-energy hydrogen atom, was predicted to be a highly reactive intermediate which further reacts to form a novel hydride ion. The predicted hydride ion of hydrogen catalysis by either cesium atom or  $Ar^+$  catalyst is the hydride ion  $H^-(1/2)$ . This ion was observed spectroscopically at  $407\text{ nm}$  corresponding to its predicted binding energy of  $3.05\text{ eV}$ .

8. R. Mills, N. Greenig, S. Hicks, "Optically Measured Power Balances of Anomalous Discharges of Mixtures of Argon, Hydrogen, and Potassium, Rubidium, Cesium, or Strontium Vapor", Int. J. Hydrogen Energy, in progress. [Copy submitted in Exhibit 3.] The power balances of gas cells having atomized hydrogen from pure hydrogen alone, an argon-hydrogen mixture alone, or pure hydrogen or an argon-hydrogen mixture with vaporized potassium, rubidium, cesium, strontium, sodium, or magnesium were measured by integrating the total light output corrected for spectrometer system response and energy over the visible range. The light emitted for power supplied to the glow discharge increased by over two orders of magnitude depending on the presence of less than 1% partial pressure of certain of the alkali or alkaline earth metals in hydrogen gas or argon-hydrogen gas mixtures. Whereas, other chemically similar metals had no effect on the plasma. The metal vapor enhancement of the emission was dramatically greater with an argon-hydrogen mixture versus pure hydrogen, and a 97 % argon and 3 % hydrogen mixture had greater emission than either gas alone. Only those atoms or ions which ionize at integer multiples of the potential energy of atomic hydrogen, potassium, cesium,  $Rb^+$ , strontium, and  $Ar^+$  caused an increase in emission; whereas, no anomalous behavior was observed in the case of  $Mg(m)$  and  $Na(m)$  which do not provide a reaction with a net enthalpy of a multiple of the potential energy of atomic hydrogen. The light intensity versus power input of a mixture of these metals with hydrogen, argon, or argon-hydrogen gas was the same as that of the corresponding gas alone. At an input power to the glow discharge of 10 watts, the optically measured light output power of a mixture of strontium, cesium, potassium, and rubidium with 97 % argon and 3 % hydrogen was 750, 70, 25, 15, and  $10 \mu W/cm^2$ , respectively. Whereas, the optically measured light output power of sodium or magnesium with 97 % argon and 3 % hydrogen was about  $5 \mu W/cm^2$ , and the result for hydrogen or argon gas alone was  $1.5 \mu W/cm^2$ . A temperature dependence of some of the anomalous plasmas was determined corresponding to the partial pressure dependence of the metal. These studies provide useful parameters for the optimization of the catalytic reaction of atomic hydrogen.

9. R. Mills and M. Nansteel, "Anomalous Argon-Hydrogen-Strontium Discharge", IEEE Transactions of Plasma Science, submitted. [Copy submitted to PTO in Exhibit 6.] I report the observation of intense extreme ultraviolet (EUV) emission from incandescently heated atomic hydrogen and atomized strontium that increased with argon. Typically the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF

coupling (e.g.  $>10^6$  K) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3$  K) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and atomic strontium which was vaporized from the metal by heating. The emission intensity of the plasma generated by atomic strontium increased significantly with the introduction of argon gas only when  $Ar^+$  emission was observed. No emission was observed with hydrogen when sodium, magnesium, or barium replaced strontium or with hydrogen, hydrogen-argon mixtures, or strontium alone. The power balance of a gas cell having vaporized strontium and atomized hydrogen from pure hydrogen or argon-hydrogen mixture (77/23%) was measured by integrating the total light output corrected for spectrometer system response and energy over the visible range. Hydrogen control cell experiments were identical except that sodium, magnesium, or barium replaced strontium. In the case of hydrogen-sodium, hydrogen-magnesium, and hydrogen-barium mixtures, 4000, 7000, and 6500 times the power of the hydrogen-strontium mixture was required, respectively, in order to achieve that same optically measured light output power. With the addition of argon to the hydrogen-strontium plasma, the power required to achieve that same optically measured light output power was reduced by a factor of about two. The power required to maintain a plasma of equivalent optical brightness with strontium atoms present was 8600 and 6300 times less than that required for argon-hydrogen and argon control, respectively. A plasma formed at a cell voltage of about 250 V for hydrogen alone and sodium-hydrogen mixtures, 140-150 V for hydrogen-magnesium and hydrogen-barium mixtures, 224 V for an argon-hydrogen mixture, and 190 V for argon alone; whereas, a plasma formed for hydrogen-strontium mixtures and argon-hydrogen-strontium mixtures at extremely low voltages of about 2 V and 6.6 V, respectively.

10. R. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy, Int. J. Hydrogen Energy, in press. [Copy submitted to PTO in Exhibit 7.] Novel inorganic alkali and alkaline earth hydrides of the formula  $MH^*$ ,  $MH_2^*$ , and  $MH^*X$  wherein  $M$  is the metal,  $X$  is a halide, and  $H^*$  comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and  $MH$ ,  $MH_2$ , or  $MX$  corresponding to an alkali metal or alkaline earth metal compound, respectively. Novel hydride ions of the corresponding novel hydride compounds were characterized by an extraordinary upfield shifted peak observed by  $^1H$  nuclear magnetic resonance spectroscopy.

11. R. Mills, M. Nansteel, and Y. Lu, "Anomalous Hydrogen-Strontium Discharge", European Journal of Physics D, submitted. [Copy submitted to PTO in Exhibit 10.] I report the observation of intense extreme ultraviolet (EUV) emission from incandescently heated atomic hydrogen and atomized strontium. Typically the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $>10^6 K$ ) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and atomic strontium which was vaporized from the metal by heating. No emission was observed when sodium, magnesium, or barium replaced strontium or with hydrogen or strontium alone. The power balance of a gas cell having atomized hydrogen and strontium was measured by integrating the total light output corrected for spectrometer system response and energy over the visible range. Control cell experiments were identical except that sodium, magnesium, or barium replaced strontium. In the case of hydrogen-sodium, hydrogen-magnesium, and hydrogen-barium mixtures, 4000, 7000, and 6500 times the power of the hydrogen-strontium mixture was required, respectively, in order to achieve that same optically measured light output power. A plasma formed at a cell voltage of about 250 V for hydrogen alone and sodium-hydrogen mixtures, and 140-150 V for hydrogen-magnesium and hydrogen-barium mixtures; whereas, a plasma formed for hydrogen-strontium mixtures at an extremely low voltage of about 2 V.

12. R. Mills, J. Dong, Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", Int. J. Hydrogen Energy, Vol. 25, (2000), pp. 919-943. [Copy submitted to PTO in Exhibit 11.] Typically the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $>10^6 K$ ) with confinement provided by a toroidal magnetic field. I report the observation of intense EUV emission at low temperatures (e.g.  $<10^3 K$ ) from atomic hydrogen and certain atomized pure elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen.

13. R. Mills, "Observation of Extreme Ultraviolet Emission from Hydrogen-KI Plasmas Produced by a Hollow Cathode Discharge", Int. J. Hydrogen Energy, Vol. 26, No. 6 (2001) pp. 579–592. [Copy submitted to PTO in Exhibit 12.] A high voltage discharge of hydrogen with and without the presence of a source of potassium, potassium iodide, in the discharge was performed at INP Greifswald, Germany under my supervision using a hollow cathode. An intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g.  $< 10^3 K$ ) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen,  $27.2 eV$  [1, 3-5]. Two potassium ions or a potassium atom may each provide an electron ionization or transfer reaction that has a net enthalpy equal to an integer multiple of  $27.2 eV$ . The spectral lines of atomic hydrogen were intense enough to be recorded on photographic films only when  $KI$  was present. EUV lines not assignable to potassium, iodine, or hydrogen were observed at 73.0, 132.6, 513.6, 677.8, 885.9, and 1032.9 Å. The lines are assigned to transitions of atomic hydrogen to lower energy levels corresponding to lower energy hydrogen atoms called hydrino atoms and the emission from the excitation of the corresponding hydride ions formed from the hydrino atoms.

14. R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a Ti-K<sub>2</sub>CO<sub>3</sub>-H-Cell", Int. J. Hydrogen Energy, Vol. 26, No. 4 (2001) pp. 327–332. [Copy submitted to PTO in Exhibit 13.] INP Greifswald, Germany conducted an experiment under my supervision during which the generation of a hydrogen plasma and extreme ultraviolet emission was recorded via the hydrogen Balmer emission in the visible range. Typically a hydrogen plasma is generated and the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $> 10^6 K$ ) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator coated with potassium carbonate. The temporal behavior of the plasma was recorded via hydrogen Balmer alpha line emission when all power into the cell was terminated. A two second decay of the plasma was observed after a fast decay of the electric field to zero. The persistence of emission following the removal of all of the power to the cell indicates that a novel chemical power source is present that forms an energetic plasma in hydrogen. No unusual behavior was observed with the control sodium carbonate.

15. R. Mills, T. Onuma, and Y. Lu, "Formation of a Hydrogen Plasma from an Incandescently Heated Hydrogen-Catalyst Gas Mixture with an Anomalous Afterglow Duration", Int. J. Hydrogen Energy, in press. [Copy submitted to PTO in Exhibit 14.] I report the generation of a plasma of hydrogen and certain alkali ions as recorded via EUV spectroscopy and the hydrogen Balmer and alkali line emissions in the visible range. Typically a hydrogen plasma is generated and the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $>10^6 K$ ) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and a catalyst comprising one of potassium, rubidium, cesium, and their carbonates and nitrates. These atoms and ions ionize to provide a catalyst with a net enthalpy of reaction of an integer multiple of the potential energy of atomic hydrogen ( $m \cdot 27.2 \text{ eV}$   $m = \text{integer}$ ) to within 0.17 eV and comprise only a single ionization in the case of a potassium or rubidium ion. Whereas, the chemically similar atoms of sodium and sodium and lithium carbonates and nitrates which do not ionize with these constraints caused no emission. To test the electric dependence of the emission, the weak electric field of about 1 V/cm was set and measured to be zero in  $< 0.5 \times 10^{-6} \text{ sec}$ . An anomalous afterglow duration of about one to two seconds was recorded in the case of potassium, rubidium, cesium,  $K_2CO_3$ ,  $RbNO_3$ , and  $CsNO_3$ . Hydrogen line or alkali line emission was occurring even though the voltage between the heater wires was set to and measured to be zero. These atoms and ions ionize to provide a catalyst with a net enthalpy of reaction of an integer multiple of the potential energy of atomic hydrogen to within less than the thermal energies at  $\approx 10^3 K$  and comprise only a single ionization in the case of a potassium or rubidium ion. Since the thermal decay time of the filament for dissociation of molecular hydrogen to atomic hydrogen was similar to the anomalous plasma afterglow duration, the emission was determined to be due to a reaction of atomic hydrogen with a catalyst that did not require the presence of an electric field to be functional.

16. R. Mills, M. Nansteel, and Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Strontium that Produced an Anomalous Optically Measured Power Balance", Int. J. Hydrogen Energy, Vol. 26, No. 4 (2001) pp. 309-326. [Copy submitted to PTO in Exhibit 15.] I report the observation of intense extreme ultraviolet (EUV) emission from incandescently heated atomic hydrogen and atomized

strontium. It has been reported that intense EUV emission was observed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen,  $27.2 eV$ . Strontium ionizes at integer multiples of the potential energy of atomic hydrogen. Typically the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $> 10^6 K$ ) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and atomic strontium which was vaporized from the metal by heating. No emission was observed when sodium, magnesium, or barium replaced strontium or when argon replaced hydrogen with strontium. The power balance of a gas cell having atomized hydrogen and strontium was measured by integrating the total light output corrected for spectrometer system response and energy over the visible range. A control cell was identical except that sodium replaced strontium. In this case, 4000 times the power of the strontium cell was required in order to achieve that same optically measured light output power. A plasma formed at a cell voltage of about 250 volts in the cell with hydrogen alone and in the cell with hydrogen and sodium; whereas, a plasma formed in the strontium cell at the extremely low voltage of about 2 volts. The starting and maintenance discharge voltages were two orders of magnitude of that predicted by current theory or observed experimentally.

17. R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1185-1203. [Copy submitted to PTO in Exhibit 18.] A novel inorganic hydride compound *KHI* which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and potassium iodide. Potassium iodo hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy,  $^1H$  and  $^{39}K$  nuclear magnetic resonance spectroscopy, Fourier transform infrared spectroscopy, electrospray ionization time of flight mass spectroscopy, liquid chromatography/mass spectroscopy, thermal decomposition with analysis by gas chromatography, and mass spectroscopy, and elemental analysis. Hydride ions with increased binding energies may form many novel compounds with broad applications.

18. R. Mills, "Novel Inorganic Hydride", Int. J. of Hydrogen Energy, Vol. 25, (2000), pp. 669-683. [Copy submitted to PTO in Exhibit 19.] A novel inorganic hydride compound  $KH\ KHCO$ , which is stable in water and comprises a high binding energy hydride ion was isolated following the electrolysis of a  $K_2CO_3$  electrolyte. Inorganic hydride clusters  $K[KH\ KHCO_3]$  were identified by Time of Flight Secondary Ion Mass Spectroscopy. Moreover, the existence of a novel hydride ion has been determined using X-ray photoelectron spectroscopy, and proton nuclear magnetic resonance spectroscopy. Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

19. R. Mills, B. Dhandapani, M. Nansteel, J. He, T. Shannon, A. Echezuria, "Synthesis and Characterization of Novel Hydride Compounds", Int. J. of Hydrogen Energy, Vol. 26, No. 4 (2001) pp. 339-367. [Copy submitted to PTO in Exhibit 20.] Novel inorganic alkali and alkaline earth hydrides of the formula  $MHX$  and  $MHMX$  wherein  $M$  is the metal,  $X$  is a singly negatively charged anion, and  $H$  comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and  $MX$  or  $MX_2$ , corresponding to an alkali metal or alkaline earth metal, respectively. It has been reported that intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g.  $\approx 10^3\ K$ ) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen,  $27.2\ eV$ . These atomized elements or certain gaseous ions comprised the catalyst to form  $MHX$  and  $MHMX$ . For example, atomic hydrogen was reacted with strontium vapor and  $SrBr_2$  to form  $SrHBr$ . Novel hydride compounds such as  $SrHBr$  were identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy, proton nuclear magnetic resonance spectroscopy, and thermal decomposition with analysis by gas chromatography, and mass spectroscopy. Hydride ions with increased binding energies form novel compounds with potential broad applications such as a high voltage battery for consumer electronics and electric vehicles. In addition, these novel compositions of matter and associated technologies may have far-reaching applications in many industries including chemical, electronics, computer, military, energy, and aerospace in the form of products such as propellants, solid fuels, surface coatings, structural materials, and chemical processes.

20. R. Mills, "Highly Stable Novel Inorganic Hydrides", Journal of Materials Research, submitted. [Copy submitted to PTO in Exhibit 21.] Novel inorganic hydride compounds

$KH$   $KHCO_3$ , and  $KH$  were isolated following the electrolysis of a  $K_2CO_3$  electrolyte. The compounds which comprised high binding energy hydride ions were stable in water, and  $KH$  was stable at elevated temperature (600 °C). Inorganic hydride clusters  $K[KH\ KHCO_3]_n$  were identified by positive Time of Flight Secondary Ion Mass Spectroscopy (ToF-SIMS) of  $KH\ KHCO_3$ . The negative ToF-SIMS was dominated by hydride ion. The positive and negative ToF-SIMS of  $KH$  showed essentially  $K^+$  and  $H^-$  only, respectively. Moreover, the existence of novel hydride ions was determined using X-ray photoelectron spectroscopy, and proton nuclear magnetic resonance spectroscopy. Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

21. R. Mills, "Novel Hydrogen Compounds from a Potassium Carbonate Electrolytic Cell", Fusion Technology, Vol. 37, No. 2, March, (2000), pp. 157-182. [Copy submitted to PTO in Exhibit 22.] Novel compounds containing hydrogen in new hydride and polymeric states which demonstrate novel hydrogen chemistry have been isolated following the electrolysis of a  $K_2CO_3$  electrolyte with the production of excess energy. Inorganic hydride clusters  $K[KH\ KHCO_3]_n$  and hydrogen polymer ions such as  $OH_{23}^+$  and  $H_{16}^-$  were identified by time of flight secondary ion mass spectroscopy. The presence of compounds containing new states of hydrogen were confirmed by X-ray photoelectron spectroscopy, X-ray diffraction, Fourier transform infrared spectroscopy, Raman spectroscopy, and proton nuclear magnetic resonance spectroscopy.

22. Mills, R., Good, W., "Fractional Quantum Energy Levels of Hydrogen", Fusion Technology, Vol. 28, No. 4, November, (1995), pp. 1697-1719. Copy submitted to PTO in Exhibit 25. Determination of excess heat release during the electrolysis of aqueous potassium carbonate by the very accurate and reliable method of heat measurement, flow calorimetry; describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by X-ray Photoelectron Spectroscopy (XPS); describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by emissions of soft X-rays from dark matter; and describes the experimental identification of hydrogen molecules in fractional quantum energy levels—dihydrino molecules by high resolution magnetic sector mass spectroscopy with ionization energy determination. Excess power and heat were observed during the electrolysis of aqueous potassium carbonate. Flow calorimetry of pulsed current electrolysis of aqueous potassium carbonate at a nickel cathode was performed in a single-cell dewar. The average power out of 24.6 watts exceeded the average input power

(voltage times current) of 4.73 watts by a factor greater than 5. The total input energy (integration of voltage times current) over the entire duration of the experiment was 5.72 MJ; whereas, the total output energy was 29.8 MJ. No excess heat was observed when the electrolyte was changed from potassium carbonate to sodium carbonate. The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers:  $n = 1/2, 1/3, 1/4, \dots$ . Transitions to these lower energy states are stimulated in the presence of pairs of potassium ions ( $K^+/K^+$  electrocatalytic couple) which provide 27.2 eV energy sinks. The identification of the  $n = 1/2$  hydrogen atom,  $H(n = 1/2)$  is reported. Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University). A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate cells. The binding energy (in vacuum) of  $H(n = 1/2)$  is 54.4 eV. Thus, the theoretical and measured binding energies for  $H(n = 1/2)$  are in excellent agreement. Further experimental identification of hydrinos—down to  $H(n = 1/8)$ —can be found in the alternative explanation by me for the soft X-ray emissions of the dark interstellar medium observed by Labov and Bowyer of the Extreme UV Center of the University of California, Berkeley. The agreement between the experimental spectrum and the energy values predicted for the proposed transitions is remarkable. The reaction product of two  $H(n=1/2)$  atoms, the dihydrino molecule, was identified by mass spectroscopy (Shrader Analytical & Consulting Laboratories). The mass spectrum of the cryofiltered gases evolved during the electrolysis of a light water  $K_2CO_3$  electrolyte with a nickel cathode demonstrated that the dihydrino molecule,  $H_2(n = 1/2)$ , has a higher ionization energy, about 63 eV, than normal molecular hydrogen,  $H_2(n = 1)$ , 15.46 eV. The high resolution (0.001 AMU) magnetic sector mass spectroscopic analysis of the postcombustion gases indicated the presence of two peaks of nominal mass two-- one peak at 70 eV and one peak at 25 eV. The same analysis of molecular hydrogen indicates only one peak at 25 eV and one peak at 70 eV. In the case of the postcombustion sample at 70 eV, one peak was assigned as the hydrogen molecular ion peak,  $H_2^+ (n = 1)$ , and one peak was assigned as the dihydrino molecular peak,  $H_2^+ (n = 1/2)$  which has a slightly larger magnetic moment.

23. Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", Fusion Technology, Vol. 25, 103 (1994). [Copy submitted to PTO in Exhibit 26.] Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel cathode was performed by Thermacore, Inc. under my supervision. The excess power out of 41 watts exceeded the total input power given by the product of the electrolysis voltage and current by a factor greater than 8. Elemental analysis of the electrolyte and metallurgical analysis of the cathode showed no evidence of chemical reactions. The pH, specific gravity, concentration of  $K_2CO_3$ , and the elemental analysis of the electrolyte sample taken after 42 days of continuous operation were unchanged from that of the values obtained for the electrolyte sample taken before operation. Elemental analysis and scanning electron microscopy of metallurgical samples of the nickel cathode taken before operation and at day 56 of continuous operation were identical indicating that the nickel cathode had not changed chemically or physically. Scintillation counter and photographic film measurements showed that no radiation above background was detected indicating that nuclear reactions did not occur. The "ash" of the exothermic reaction is atoms having electrons of energy below the "ground state" which are predicted to form molecules. The predicted molecules were identified by lack of reactivity with oxygen, by separation from molecular deuterium by cryofiltration, and by mass spectroscopic analysis. The combustion of the gases evolved during the electrolysis of a light water  $K_2CO_3$  electrolyte ( $K^+/K^+$  electrocatalytic couple) with a nickel cathode was incomplete. The mass spectroscopic analysis (Dr. David Parees of Air Products & Chemicals, Inc.) of the  $m/e = 2$  peak of the combusted gas demonstrated that the dihydrino molecule,  $H_2(n = 1/2)$ , has a higher ionization energy than  $H_2$ . Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cells by HydroCatalysis Power Corporation. Excess power out exceeded input power by a factor greater than 16. No excess heat was observed when the electrolyte was changed from potassium carbonate to the control sodium carbonate. The faraday efficiency was measured volumetrically to be 100%.

24. R. Mills and S. Kneizys, Fusion Technol. Vol. 20, 65 (1991). [Copy submitted to PTO in exhibit 27.] Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cells by me at Franklin and Marshall College and Kneizys of Ursinus College under

my supervision. Excess power out exceeded the input power by a factor greater than 37. No excess heat was observed when the electrolyte was changed from potassium carbonate to the control sodium carbonate.

25. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By Dr. Randell L. Mills

Dr. Randell L. Mills

Date: 6/21/01

**Publications:**

1. R. Mills, P. Ray, Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter, *Int. J. Hydrogen Energy*, submitted.
2. R. Mills, P. Ray, Spectroscopic Identification of a Novel Catalytic Reaction of Potassium and Atomic Hydrogen and the Hydride Ion Product, *Int. J. Hydrogen Energy*, submitted.
3. R. Mills, "BlackLight Power Technology-A New Clean Hydrogen Energy Source with the Potential for Direct Conversion to Electricity", *Proceedings of the National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001), pp. 671-697.
4. R. Mills, W. Good, A. Voigt, Jinquan Dong, "Minimum Heat of Formation of Potassium Iodo Hydride", *Int. J. Hydrogen Energy*, in press.
5. R. Mills, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", *Int. J. Hydrogen Energy*, in press.
6. R. Mills, N. Greenig, S. Hicks, "Optically Measured Power Balances of Anomalous Discharges of Mixtures of Argon, Hydrogen, and Potassium, Rubidium, Cesium, or Strontium Vapor", *Int. J. Hydrogen Energy*, in progress.
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1. R. Mills, J. He, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
2. R. Mills, B. Dhandapani, M. Nansteel, N. Greenig, S. Hicks, J. Dong, "Optically Measured Power Balances of Anomalous Discharges of Mixtures of Argon, Hydrogen, and Potassium, Rubidium, Cesium, or Strontium Vapor", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
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